

ART. IX.—*The relation of the Dew Point to the Diseases of marshy lands.*

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MARSHY lands, in which an extensive surface of wet soil is exposed to the action of the sun, and which are more or less perfectly sheltered from winds, are notoriously unhealthy. The diseases prevailing in such situations, differ according to several conditions of temperature, and the nature of the soil. We wish, distinctly, to separate the morbid agents, supposed to be associated in producing the gravest marsh diseases. They may be enumerated under three heads:—1st, the atmospheric condition of marshes and swamps: 2d, the effects of high temperatures: 3d, the specific miasm of marshes and swamps. In this place we confine ourselves to the first topic; the second may be considered hereafter, and the third has already been discussed in this Journal, January, 1843.

While it is certain that a class of diseases is universally attributed to marshy countries, it is not to be overlooked that many of these may arise independently of such localities. Intermittents, bilious fevers, and yellow fever, have been seen in persons and places where the agency of marshes could not be discovered. Such instances enforce the truth that in medicine as well as in physics given results may be reached by various means, and that general laws are to be promulgated with extreme caution.

The atmospheric condition of marshes.—The atmosphere immediately over marshy lands betrays the remarkable feature of a nearly saturated dew, point. This is especially the case in such places as are sheltered from winds by forests, or other natural objects. Those who are familiar with such districts, will not be surprised at this condition—the morning fog and evening haze which hang over them, are proofs of the high state of the dew point. This evidence is not however sufficient.

During the summer of the year 1842, I kept a register of the dew point over a marsh situated at a short distance from Hampden Sidney College, Va. The place was of limited extent, and quite protected from winds; on three sides it was bounded by steep hills, and on the fourth was extended into a dense forest. The dew point was taken at intervals during the months of July and August, the days selected being clear, and the time of examination 2 o'clock P. M. The means used for taking the dew point were a thermometer, a small flask of very thin glass, and spring water obtained on the spot. The place of observation was four feet above the soil, under the shade of a dense tree, and where no direct or reflected rays of heat could reach the thermometer. The flask being perfectly clean, spring water was poured in to half its contents; a film of dew instantly appeared on the outside; the thermometer was then introduced and moved

to and fro, until the dew was about disappearing. The temperature observed at this moment is the true dew point, or that degree of heat which represents the amount of vapour of water existing in the atmosphere.

My object being to test the amount of vapour in the air over a sheltered marsh, the measures were not made so frequently as for meteorological purposes. I found that there was seldom a difference exceeding six degrees between the dew point and atmospheric temperature, and the average difference between these measures did not often exceed 4° Fahrenheit. Therefore, so far as these observations can be adduced, the air four feet above a sheltered marsh is, even during the height of summer, so fully charged with vapour of water as to be within a few degrees of saturation during the day, and surcharged with vapour at night. The temperatures taken, varied between 75° and 92° Fh., and the average dew point at 2 o'clock P. M. was nearly 80° Fh. These measures were made, it is to be remembered, in calm air.

From some observations made in the college, at a distance of seven hundred feet, and elevated about one hundred and fifty feet, the air during the same season exhibited a dryness of 12, 16 and 21 degrees Fahrenheit above the marsh. The measures in this place were not, however, intended at the time for comparison, and are imperfect in this respect. The condition of the air for three months in the year 1841, was, however, measured by other observers, and I find that it exhibited a dryness of 17 degrees at Gettysburgh, and 20 degrees at Lancaster, Pennsylvania. The drying power would probably be rather higher in Virginia from the greater summer temperature.

I would suggest to future observers the expediency of conducting a cotemporaneous examination at the marsh, and an adjacent elevation out of the influence of the column of air over the former position. In this way the comparative dryness of the two stations is fully ascertained. Daniell's hygrometer is superior to the arrangement used by myself, and will give results in cold weather, when spring water is useless; it is an instrument of great delicacy, and acts with rapidity. A year or two ago the military stations were furnished with this valuable implement, but by the report made, it appears that some parties have discarded them as unsuited to "our arid climate." This report is, however, opposed to the experience of persons abundantly competent to use the hygrometer, as Professor Loomis and Captain Sabine. The former gentleman has measured a drying power of 37° Fahr., which is the greatest in the United States during seven years. Captain Sabine, and others, have used it in the Tropics. The effect of the report is much to be regretted, because there is no substitute for Daniell's implement. The wet bulb hygrometer which has been substituted is valueless; the results vary with different observers, and the measures obtained have to be submitted to calculation to reach the dew point. It is to be hoped that the proper authorities will not persist

in discarding the best instrument extant, and using the worst in endeavouring to obtain hygrometrical observations, the value of which to meteorology and the etiology of disease is above all calculation.

For stationary observatories, where it is desirable to ascertain the dew point repeatedly during the day, Professor Bache's instrument is the most desirable, but it requires a supply of ice, and cannot be transported with the same facility as that of Daniell.

The air of sheltered marshes being constantly saturated with moisture, an interesting consequence follows. The same bulk of air contains appreciably less oxygen gas than in salubrious and dry localities at the same temperature and elevation. The average summer temperature at Lancaster, Pa., as ascertained by Dr. Atlee, is 81° Fahr.; in Va. it would be rather higher; the average dew point during the season was 61.8 , leaving a drying power of 19.2° Fahr., which may be taken at 20° Fahr.;—the summer dew point of the marsh was nearly 80° Fahr. in Va.—Here is a difference of 20° Fahr., or from 60° to 80° in the dew point of two places which severally represent a marshy site and a healthy ordinary location.

The amount of oxygen gas displaced by the excess of 20° Fahr. dew point is nearly equal to $\frac{1}{6}$ th of all that is present at 80° Fahr. temperature. Thus, the elastic force of vapour of water at 60° Fahr. is 0.52 inch; at 80° Fahr. is 1.00 inch—(Dalton;) therefore the displacement of air in the first case will be $\frac{1}{6}$ th, and in the second $\frac{1}{3}$ st; the difference will be nearly $\frac{1}{6}$ th of the whole bulk. The actual amount of oxygen thus driven out from a cubic foot is readily discovered, for the vapour at 60° Fahr. is 6.22 grs., and at 80° Fahr. is 11.33 grs.—(Daniell;) the amount of air displaced in each cubic foot to make way for this vapour will be 8.41 grs. at 60° D. P., and 16.03 grs. at 80° D. P., the temperature in both cases being 80° Fahr. Thus there will be dislodged 28.32 cubic inches of air in the former case, and 54.0 cubic inches in the latter, of which 10.8 cubic inches will be pure oxygen. There will be a difference of 5.13 cubic inches of oxygen between the two situations.

This case exhibits in a striking manner the vitiated condition of the atmosphere of marshes in warm countries. The instance is by no means extreme. The diminution of oxygen in the air of hot climates has been adduced, by Liebig, as a cause of hepatic diseases. But however elevated the temperature or moisture may be, so long as they do not reach 98° Fahr. there will be no effect on the aëration of the blood, for all the air inspired, whether in the arctic or tropic zone, is warmed by its passage through the nares to the temperature of the lungs. The only effect that ensues is the exhalation of moisture when the dew point is under 98° Fahr., and the separation of heat from the mucous surfaces to give the inspired air a temperature of 98° Fahr. So far as the aëration of the blood in the lungs is concerned, the absence of $\frac{1}{6}$ th or more of oxygen gas will produce no result, the presence of moisture will depress exhalation. On the skin

the absence of oxygen may produce some effect, but to what extent we are unprepared to state.

The atmospheric condition of marshes is different from that of the sea or of deep waters.—The amount of vapour of water over marshes is supposed to be the cause of their peculiar unhealthiness: hence most persons suppose that over the sea similar effects should exist. It is a general impression that the air of seas and the ocean is saturated with water. Under this belief we find it universally objected to that theory of malaria which regards the moisture of the air as the injurious cause, that marsh fevers should prevail extensively at sea. But the dew point over the sea does not appear to be relatively higher than in dry places, and to be, for the most part, much lower than that of marshes.

In laying down the position that the atmosphere over the sea, where it is uninfluenced by currents, is dryer than that over stagnant marshes, I place myself in opposition to the received notions or prejudices of most persons and even of apparent truth. The subject is, however, worthy of serious investigation, for whereas those authors who are opposed to the theory of the malarious nature of a high dew point, confidently appeal to the salubrity of the ocean, the advocates of the theory either avoid the difficulty, or, with Mr. T. Hopkins, (*Lond. Edinb. Phil. Mag.*, No. 86,) take it for granted that intermittents do occur thereupon. The hygrometrical condition of the ocean has never been made the subject of general investigation; none of the great meteorological writers seem to have turned their thoughts to the subject, so far as the dew point is concerned. The only series of observations which I have met with is by Captain Sabine, during his voyage to the tropics, to ascertain the length of the seconds' pendulum; these are, however, numerous, exceeding four hundred, and many being made on shore, a means of comparison is presented by the same observer. The great accuracy of Captain Sabine renders this series worthy of the highest confidence. Examinations, at sea, with Daniell's hygrometer, are often made between decks, and do not indicate the atmospheric dew point, but that of a confined and damp room. So small a number of observations as four hundred would be of little value for meteorological purposes, but are amply sufficient to enable us to form a correct idea of the average drying power of the air.

The register was first kept between Madeira and Sierra Leone, and commences Feb. 20th, 1822. In this voyage three measures were made daily at 8 A. M., 1 and 6 P. M., the temperature of the air and water and dew point being taken: the observations were continued in the Gambia and Rio Grande rivers.—The mean temperature was 70° Fahr., and it did not rise above 74°, or fall below 66° Fahr.—the mean dew point was 57·7° Fahr.—hence the average dryness, or drying power was 12·3° Fahr.—this was never depressed below 7°, and rose during the Harmattan to 29° Fahr.—

and to 16.4 during a brisk breeze. In this register are contained several measures over rivers, the water of which was 5° to 8° Fahr. above the temperature of the sea.

Contrast these measures at sea with those made on shore at Sierra Leone, from the 25 Feb. to March 22; during this season, the average mean of the thermometer was $78^{\circ}.85$ Fahr., the average dew point 72.7 , seldom sinking two degrees below this, so that the drying power was but 6.15 , or only half of what it was in the adjacent seas.

The same admirable observer furnishes us with materials for rectifying errors springing from imperfect examinations of the moisture of the atmosphere over the ocean. We find that along the shore of Guinea, and in the equinoctial current, where the sea is warmer than the air, either by the ingress of the tepid waters of rivers, or the circulation of tropical waters, the drying power falls to an average of 5 degrees: in other words it is then as high as at Sierra Leone. In sailing to the island of Ascension, from the river Gaborn, in Africa, the drying power over the equinoctial current was 6° Fahr. at 8 hours A. M., and rose to 9° Fahr. at the same hour, when they had passed out of it.

Observations made at Ascension, from June 25th to July 5th, give a mean of 75° Fahr. at 8 hours A. M., and 84° at 3 hours P. M., the dew point being 65° Fahr., and 70° Fahr.—the drying power 10° Fahr. at 8 A. M., and 14° Fahr. at 3 P. M.,—measures almost identical with those of the adjacent seas. These measures are true for Bahia at the end of July; the average dryness of the air from Bahia to Pernambuco, was 8° Fahr. at 8 A. M.

The examination of all these observations, which are to be found in Daniell's meteorology, shows that the drying power of the air, when the ship was not sailing through warm currents or on coasts, where many rivers were discharging tepid waters, attained from 6° to 10° Fahr. in the morning at 9 A. M., and may be taken at an average of 12° Fahr. for the whole voyage, lasting from February to November, and between Madeira and Bahia. In this time the thermometer ranged, between 65° and 84° Fahr., it was therefore the most favourable season for examining the question.

In comparing these with the measures made at inland situations, free from malaria, as at London, Greenwich, Hudson, in Ohio, Toronto, Lancaster and Gettysburgh, Pennsylvania, we find the average drying power at sea equally high and even greater than in some of these places.

At Hudson, Ohio, by Professor Loomis's observations, made during seven years, we find the average drying power at 9 hours A. M. but $6^{\circ}.2$ Fahr. in the months of May, June, July, August, and September, the temperature ranging between 58° Fahr. and 72° Fahr. at the same time.

In London, from observations made at the rooms of the Royal Society, the average drying power at 9 hours A. M. is only $5^{\circ}.3$ Fahr., during the months of June, July, August, September, and October; the temperature

during this season, at the same hour, varying from 47°.2 Fahr. to 64°.3 Fahr.

The measures at Greenwich, and Toronto, Upper Canada, are almost identical with London, and Hudson, Ohio.

The registers at Lancaster and Gettysburgh, kept by Dr. Atlee and Professor Jacobs, are not comparable with the preceding, because the dew point is given for 2 hours P. M., and is not ascertained directly by Daniell's hygrometer, but by means of that miserable contrivance, the wet bulb thermometer. The dew point at 9 A. M. is necessarily lower than at 2 P. M., which latter is near the moment of maximum; in Captain Sabine's observations the drying power at 9 hours A. M. was often 6° Fahr., and 12° Fahr., or 14° Fahr. at 2 hours P. M.—a difference of one half; in Professor Loomis's observations, the difference is nearly half, between the measures at 9 hours and 3 hours; if, therefore, we reduce the measures in the tables for Lancaster and Gettysburgh to this extent, they will then compare with the preceding averages.

Table of the mean dew point, temperature, and drying power at 2 h. P. M., at Lancaster and Gettysburgh during the Winter, Spring, Summer, and Autumn of 1841.

PLACES.	WINTER.			SPRING.			SUMMER.			AUTUMN.		
	Temp.	Dew point.	Drying power.	Temp.	Dew point.	Drying power.	Temp.	Dew point.	Drying power.	Temp.	Dew point.	Drying power.
Lancaster	35.7	24.8	10.9	57.4	42.0	15.4	81.0	61.8	19.2	59.1	47.3	11.5
Gettysburgh	29.1	22.6	6.5	48.7	42.6	6.1	78.3	61.5	16.8	51.6	45.6	6.0

The drying power at 9 h. A. M. will therefore be 7°.7 and 3°.0 Fahr. in Spring—9°.6 and 8°.4 Fahr. in Summer—and 5°.7 and 3°.0 in Autumn; measures not much different from those of the sea for Lancaster and lower at Gettysburgh. I am not, however, quite certain of the time of observation at the latter place.

We have, therefore, as a mean drying power at sea 8 degrees at 9 h. A. M., and 6°.2, 5°.3, 7°.7, 9°.6, 5°.7, during similar seasons and temperatures inland—the average dryness, it will be seen, is therefore one degree in favour of the atmosphere of the ocean. This result is not presented as perfect, but as extremely remarkable, and pointing to a fact altogether new, for no meteorologist has any notice or suspicion of it. I think the data, although very imperfect, are sufficient to establish the general fact, that the degree of dryness can only be reached by numerous observations, which must be made, like Capt. Sabine's, with the greatest care, and on the upper deck, under an awning, and not in confined cabins, like those of Mr. Caldcleugh.

It may be interesting to consider the theoretical reasons of this high drying power. There are two,—the influence of winds—and the trancalesency of the ocean.

The influence of winds is seen directly in the voyage from Madeira to Sierra Leone, when, on the 25th Feb., a fresh breeze raised the drying power from $8^{\circ}7$ to $16^{\circ}4$ during its existence, and on the 5th of March, when a slight Harmattan on the Gambia River produced a drying power of 29 degrees. The ocean is nearly constantly under the influence of winds, and therefore this cause is ever active. The extent to which a moderate wind increases evaporation, or, in other words, the drying effect produced thereby, has been measured by Dr. Dalton, and a table constructed, by Dr. Ure and others, to express it for every degree within probable limits. We find that 189 grs. of water are evaporated during a high wind; 154 grs. during a medium breeze; and only 120 grs. during a calm; from the same surface of water maintained at the same temperature. These numbers may severally represent the rates of drying power under similar circumstances, and they are nearly in the ratio of 1 to $1\frac{1}{2}$ and $1\frac{1}{4}$. As the dew point is the measure of the capacity of the air for moisture, the increased power of receiving it necessarily reacts on this measure.

By the transcalesency of the sea is meant the power its clear waters possess of transmitting heat of low refrangibility without being heated thereby. Melloni (*Scient. Memoirs*, Nos. 1 and 2), first drew the attention of scientific men to the different properties of radiant heat derived from various sources, as from non-luminous substances, incandescent bodies, and the sun. The more heated the sources the lower the refrangibility. The same observer designates the rays from different sources by giving them the names of the colours of light, and thereby associating in the mind their degree of refrangibility. Heat from warm water or bodies below incandescence belongs to the violet end of the spectrum, and is entirely absorbed by the clearest water, none being transmitted by radiation. Of heat from a lamp, that is of lower refrangibility, 11 rays per cent. were transmitted by radiation. The per centage of the rays of the sun transmitted is not given, but is very much larger. This fact is readily appreciated by filling a thin glass vessel of a spherical form, and an inch or more in diameter, with clear water, and exposing it to the sun's rays; a focus will be formed in the same way as with a magnifying glass, and sufficient heat transmitted to cause the combustion of inflammable bodies. So that of every hundred rays which fall upon the sea, a large number will be transmitted to unknown depths, and probably never directly expended in heating it, for of those rays which penetrate to several feet, few only are absorbed at greater depths. As the sea derives no heat except from the sun's rays, it will be seen that its temperature will be below that of the dry earth, and less evaporation will take place from it than from a contiguous surface of damp soil heated by the same source.

The position we have endeavoured to sustain is that the dew point of the marsh sheltered from winds will be higher than over the sea. In the case of marshes little heat will be lost by transmission; it will be entirely ex-

pended in producing evaporation. This results from the shallowness and colour of the water, and the extent of solid surface. Whatever rays fall on the mud will be absorbed, and becoming converted into heat of high refrangibility, (*violet heat*), be absorbed by the moisture and effect its vapourization. The shallow waters of marshes are not only heated by all the direct rays of the sun which they are capable of absorbing, like the sea, but in addition, unlike the ocean, by the absorption of more heat from the soil. Being thus placed between two fires, the amount of evaporation will be much greater than at sea in the same season; the elastic force of the vapour will be higher, and a condition nearly approaching to saturation will be maintained in the contiguous air. How great the increased evaporation is, may be inferred from the fact that a dry soil, of light texture and dark colour, has been measured at $113^{\circ}5$ Fahr. when the air was 77° Fahr. (Schubler); and I have measured the soil of a marsh 5° below that of the air in consequence of the great evaporation going forward. In the latter case the excess of heat absorbed and five degrees upwards were employed in vapourization.

Relation of the high dew point of marshes to evaporation, and the insensible perspiration.—The dew point is a means of ascertaining the evaporative force, or rapidity of vapourization, from any wet surface for a given temperature. At a temperature of 80° Fahr., the abstract evaporative force may be represented, either in terms of the elasticity of vapour (1.01 inch Bar.) or using Daniell's table, (*Meteorological Essays*), deduced from Ure and Dalton, may be taken at 4.28 grs. of water per minute, from a circular vessel of six inches diameter, placed in calm air. The force in either case is that exerted by 80° Fahr., when there is no vapour already in the air, and it will rapidly diminish with the amount pre-existing, which latter is shown by the dew point. Thus at 80° temperature, and 0° dew point, the force equals 4.28 grs.—at 22° D. P., it is 3.72 grs.—at 50° D. P., 2.68 grs.—at 60° D. P., 2.04 grs.—at 70° D. P., 1.20 grs., and at 80° temperature and dew point, the force is zero. This diminution of force results from the pressure of vapour already existing in the air. The force is increased as already explained by the action of winds, which by constantly presenting fresh bulks of air, raise the dew point or evaporative energy.

The human body presents an evaporative surface, varying in temperature at the skin between 95° and 98° Fahr., which is ever throwing off vapour, or insensible perspiration. The exact amount of vapour, thus thrown off, has been imperfectly measured. Lavoisier and Seguin estimated the cutaneous and pulmonary exhalation at quantities varying between 98 oz. troy, and 32 oz. troy, or as averaging 53 oz. 38 grains daily, of which 32 oz. were from the skin, and 20 oz. 38 grs. from the lungs. Dalton attained a mean of $27\frac{1}{2}$ oz. daily for both exhalations; of which $6\frac{1}{2}$ oz. were from the skin, and $20\frac{1}{2}$ oz. from the lungs. We learn from these discordant results, how much the amount of exhalation is under the influ-

ence of physical and vital causes, and that no measure of this important function can be obtained of utility to physiology, without an accompanying register of the state of the dew point and other data. The value of a healthy condition is seen distinctly in the amount of the evaporation, for even assuming the minima of $27\frac{1}{2}$, and 38 oz. per diem, the quantity is sufficient to convince us of its great moment. The distinction between cutaneous and pulmonary exhalation is not to deceive us, for these are vicarious and intended to counterbalance one another; it is indeed transpiration from the skin, or mucous membrane of the air passages, and equally under the physical influence of the atmosphere. It is also maintained by some writers, that there exists a distinction between the transpiration carried on under physical laws and that which is an excretion elaborated by the cutaneous follicles; this does not affect the question of the influence of physical agents; a portion of the constituents of the insensible perspiration is of glandular origin, a portion is pure vapour of water; it is over the latter only that the dew point can exert any action. Transudation of moisture or sweat is not influenced by the dew point as to its quantity. Irritation of the cutaneous follicles, or nervous fibrils, producing various results, is not primarily the effect of a high dew point. It is over the vapour of water only that the dew point exercises a controlling influence.

The pressure of the vapour existing in the air, will exercise the same influence on the amount of insensible perspiration as over the evaporation from a surface of water. The degree of dryness necessary to a full discharge of the function, has never been directly measured. Mr. Hopkins thinks that a pressure of 60° Fahr. dew point, will arrest it sufficiently to produce agues. He obtains this measure from the supposed average dew point in summer and autumn, in Holland, Lincolnshire, &c., where intermittents prevail. But this point is probably exaggerated, for in the registers kept in the United States, the dew point seldom attains 60° Fahr. during the summer at 2 P. M., when the average temperature is 80° Fahr., and in the tropical island of St. Vincent, averages but $68^{\circ}.8$ Fahr. Mr. Hopkins, however, complicates the effect with the temperature, urging that a low saturated temperature at 60° Fahr. will be injurious, whereas a dew point of 60° Fahr., under a high temperature, would be salubrious. This seems to be unphilosophical, and can be understood only by supposing that the temperature of the skin is liable to great changes, and that with a high atmospheric temperature, the skin will also be much above 98° Fahr. The fluctuation measured by Dr. Davy was but little, and we cannot understand how the temperature should rise, without abnormal conditions, so long as the atmospheric degree is below 98° Fahr. If we take 60° Fahr. dew point, the temperature of the skin being 98° Fahr., which is the normal degree in temperate climates, we have a drying power of 38° Fahr. as the theoretical limit of healthy transpiration.

Taking 38 degrees as the amount of dryness, and Lavoisier's average

exhalation of 11 grs. by the skin and 7 grs. by the pulmonary apparatus per minute, we are prepared to consider the effect of higher dew points than 60° Fh. in arresting the quantity of insensible perspiration. The highest mean dew point measured at the unhealthy island of St. Vincent during July, 1832, was $70^{\circ}25$ Fh.; it is not stated at what time of the day. Captain Sabine's register at Bahia gives an average at 6 P. M. of $67^{\circ}6$ Fh., this was on shore at the end of July. Capt. Alexander measured the dew point at 76° Fh. and 79° Fh. off the Bight of Benin, where it is to be remembered the sea off the coast is heated by the waters of the adjacent marshes. It is probable from these observations that a dew point of 80° Fh. is never attained except over small marshes sheltered from winds.

With a dew point of 70° Fh. the drying power would be reduced to 28° Fh.; with a dew point of 80° Fh. it would be reduced to 18° Fh. The depression in either case under normal circumstances would affect the vapourization, reducing it from 18 grs. per minute to less quantities. The physical effect would be identical upon the cutaneous and so called pulmonary exhalation. The vessel of water employed by Dalton and Ure being of six inches diameter, presented a surface of nearly $28\cdot5$ square inches. A man exposes a surface of at least 2160 square inches, which is the perpendicular superficies of a cylinder five feet high and three feet in circumference. These surfaces are to one another nearly as 1 to 76. The evaporation at 98° Fh. under a pressure 60° D. P. is taken at 18 grs. per minute; this quantity becomes $15\cdot0$ grs. per minute at 70° D. P., and finally $10\cdot9$ grs. per minute at 80° D. P.—these measures being all taken in calm air. Thus from the human surface, quantities of only 18, 15 and $10\cdot9$ grs. would be evolved in a minute, whereas, under similar circumstances, water would throw off 376·9, 313·1 and 221·9 grs. From this it will be seen how exceedingly slow the cutaneous evaporation is and to what a great extent it may be developed under any abnormal condition. The evaporative surfaces are as 1 to 76—the exhalation as 20·9 to 1—and this on a calculation for the superficies of a man very much below the average, and without estimating the air passages. From these data it will be seen that the pressure of the highest dew points does not produce such a marked effect as at first might be supposed; that even at 80° D. P., which is unwarrantably high as a mean for a summer season, there is only a falling off of 7·1 grs. out of 18 grs., and this from a surface which may be supposed capable of a very much more extended evaporation, as it throws off but $\frac{1}{2}$ part of that vapourized by a like surface of water under similar forces.

It does not matter whether the mean of 18 grs. evaporation be true or not, the relative deficiency under different dew points will be in the same ratio, and this arises from the fact that the elastic force of vapour does not increase in the simple ratio of temperature, but much more rapidly; thus by Dalton's table the elastic force at 60° is 0·52; at 70° is 0·72; at 80° is 1·00; at 98° is 1·74 inch.

The office of the insensible perspiration, and the consequences flowing from a high dew point.—It is scarcely necessary to premise that insensible perspiration consists almost entirely of vapour of water—the carbonic acid, lactic acid, azotized matters, and oily parts it contains being in no way concerned in the present discussion. The production of the latter by the sebaceous follicles, or the direct transmission of gases is in no wise dependent upon the condition of the dew point primarily. The pressure of water in the atmosphere has no influence on the passage of carbonic or other gases, as many writers suppose; it is only effective in arresting the aqueous particles. We have therefore no concern for the office of insensible perspiration, except so far as the vapour of water is involved. The duty discharged by this is evidently not the simple separation of an excess of fluid, for all that rises during the day might be discharged vicariously in a few minutes. This part of the function is distinctly the effect and not the cause. But in the vapourization of so much fluid, we discern its prominent if not sole office; the removal from the body of an amount of heat—the function which is to antagonize the calorific forces and serve to attain the constant and all important healthy temperature of the body.

Direct radiation of heat from the body is not influenced by the dew point; this, with the caloric rendered latent in vapour amounting to 1114 degrees at 98° Fahr., is the most important means of keeping down the temperature of the system. Fluids evacuated are merely warmed, and remove only the excess of heat which they may have acquired. Thus it becomes evident that if the amount of insensible vapour be diminished by physical causes, the quantity of heat carried thereby from the body will be diminished. But before we examine this conclusion, it is necessary to present two positions affecting the case: first, that under the same circumstances, the number of respirations in a minute is the same at all ordinary temperatures in persons enjoying sound health; and secondly, that the amount of oxygen inhaled into the tissues of the lungs is the same at every terrestrial temperature not exceeding 98° Fahr. The first position is readily conceded by physiologists, but I am apprehensive that it is not strictly correct, although it is here assumed; of the second I have already treated. These two conditions insure the production of an uniform amount of heat in the body, whatever may be the external temperature. During cold weather, whatever excess is produced over the amount necessary to warm the system to a proper degree, will be thrown out by radiation, the latent heat of vapour, &c. In this case the amount removed by radiation will be large, and, perhaps, exceed that by vapourization. As the temperature of the air rises, the duty of cooling the body devolves on the insensible perspiration; and when it attains 98° Fahr., the latter removes nearly all the excess of heat. It is in high temperatures that the depressing effects of the high dew point may be expected to act.

There is scarcely a place in the southern half of the United States, not

mountainous, which does not present us with a dew point of 60° Fahr., and a mean temperature of 80° Fahr. during the months of July and August, and notwithstanding are perfectly salubrious. In Hudson, Ohio, the mean dew point for seven years was found at 2 h. P. M. to be $67^{\circ} \cdot 2$ Fahr., in July, and $66^{\circ} \cdot 0$ in August, with the maintenance of perfect health. In July, 1840, at Lancaster, the mean was 68° Fahr.—at Milford, Pa., the mean for August of the same year $67^{\circ} \cdot 4$, without any malarious diseases. It has already been shown that a dew point of 70° Fahr. is probably the highest mean for a month in any part of the world except where there is no circulation of air, yet there is no malaria developed by it, as the foregoing cases amply demonstrate.

At 70° dew point the evaporative force is but 28° Fahr. from the human body, yet we discover that health is maintained; this, it will be remembered, is the highest mean during July at the tropical Island of St. Vincent. Above this point the measures must be very few, and only obtained during calms and under extraordinary circumstances, for Prof. Daniell has abundantly shown that a direct consequence of the law of diffusion of vapours is that the condition of the dew point which exists at the earth's surface will be maintained to a considerable elevation; and this cannot rise much higher than 70° as a mean, because of the limiting effects of the atmospheric temperature. It is perfectly possible for the air of a sheltered ravine to attain a dew point of 90° Fahr., but where there is a play of winds, or free diffusion laterally, it becomes absolutely impossible at any terrestrial temperature.

It has been shown that at a mean of 18 grains evaporation from the body per minute for 60° dew point, the insensible perspiration will be 15 grs. at 70° Fahr., or a diminution of only 3 grains. We have seen that in the direct attempts to measure the amount of insensible perspiration, quantities were procured at different times from the same persons during health, varying between 11 grains and 32 grains per minute, for both cutaneous and pulmonary exhalation. From these experimental data we discover to how great an extent the fluctuation occurs without derangement to health, and that whilst Dalton measures the daily cutaneous exhalation at $6\frac{1}{2}$ oz., Lavoisier and Seguin give us a mean of 32 oz. The measures of the latter philosophers are probably too high, yet we find only a diminution of 3 grains per minute as the result of elevating the dew point from 60 to 70 degrees. Whatever be the true exhalation at 60° , the reduction is pro rata; if it be but 9 grains, the falling off is but $1\frac{1}{2}$ grain. In the extremest case but only 3 grains.

What will be the effect of diminishing the insensible perspiration by 3 grains per minute? Experience suggests two consequences: 1st, that an amount of sensible perspiration will accrue sufficient to compensate for this detention; 2d, that some other vicarious discharge will occur. Theory also indicates that the temperature of the skin will be increased to produce

a higher evaporative force, or, secondly, that the very much greater capacity of evaporation which belongs to a texture such as that of the body will instantly compensate for the momentary deficiency. It has been shown that a similar surface of water evaporates 21 times as fast as the body; if, therefore, an increase in the last respect amounting to only $\frac{1}{21}$ th part of the total power be established, it will compensate the 3 grains. The effect of a slight wind, by increasing the evaporation from 15 to 20 grs., would more than compensate for the detention.

A slight elevation of the cutaneous temperature would rectify the deficiency; thus at 100° Fahr. the evaporation would be 16.2 grs.—at 101°, 16.9—at 102°, 17½ grs., or within half a grain of the full quantity; and this temperature has been measured in healthy persons by Dr. Davy. The sweat would act rapidly in carrying off the amount of heat, for, being exuded, it would in a great measure evaporate from the exterior, and thus reduce the temperature of the body in the same way as the 3 grs. of insensible perspiration. The mistakes into which those who have urged the theory of the malarious nature of a high dew point have fallen, are that they have supposed the detention of insensible vapour much more considerable—the dew point much higher than it exists; and many are under the erroneous impression that a high dew point arrests the separation of carbonic acid and the other constituents of sweat.

It is often an advantage to discuss at length a plausible theory which has been fully embraced, but little investigated, for, being set forth in its details, it may lose much of its force. But, on other grounds, the doctrine that a high dew point is productive of marsh diseases, is altogether untenable, for it will be found that the mean dew point of the summer is, in the United States, upwards of 15 deg. above that of the autumnal season, and that the dew point of 60° Fahr. in the U. States is often experienced months together without ill health. On the other hand, the fens of Lincolnshire, Walcheren, the marshes of Holland, are pestiferous with a dew point of less than 50 degrees.

We do not in this paper refer to the influence of dampness, heavy dews, and the constant liability to wetness which the inhabitants of marshes experience, and which are abiding causes of sickness. These have nothing to do with the physical effects of a high dew point, and are often present when the dew point is very low.